Neuroimaging of Acute Ischemic Stroke

Amar Dhand, Harvard Medical School, Year III
Gillian Lieberman, MD

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Agenda

Introduce stroke → Neuroimaging modalities → Patient presentation
Stroke

- Definition: “sudden occurrence of a nonconvulsive, focal neurological deficit” (Victor and Ropper, p. 823)
- CVD is third most common cause of death in the US
  - 500,000 strokes/year → 175,000 fatalities
- DDx
  1. Ischemic (~80%)—arterial occlusive disease, cardiogenic emboli, hypercoaguable state, nonatheromatous disease
  2. Hemorrhagic (~20%)—intracerebral hemorrhage, vasospasm, veno-occlusive disease
  3. Non-vascular (1%)—anoxic ischemic encephalopathy, brain tumor
Neuroimaging in acute stroke

Non-contrast CT
- Q: Ischemic or hemorrhagic?

Current protocol

Multimodal CT (e.g. CT with contrast, CTP, CTA)
- Q: TPA or IR endovascular interventions?

Experimental protocol

Immediate MRI/MRA (DWI/PWI mismatch)

MRI/MRA (e.g. DWI, PWI, GRE, FLAIR)

Follow-up non-contrast CT
Current research opinions

Schramm et al. (2004) Stroke

MRI Screening Before Standard Tissue Plasminogen Activator Therapy Is Feasible and Safe
Dong-Wha Kang, MD, PhD; Julio A. Chalela, MD; William Dans, MD, Steven Warach, MD, PhD; NIH-Suburban Stroke Center Investigators

Background and Purpose—MRI screening for thrombolytic therapy may improve patient selection. Alternatively, it may excessively delay treatment and thereby lead to worse outcomes. We hypothesized that times to treatment and outcomes in a stroke center with immediate MRI access and interpretation would not differ from those of the typical clinical practice.

Methods—We compared the results of 120 consecutive patients treated with intravenous tissue plasminogen activator (t-PA) within 3 hours of onset at our center with those of the 2 largest multicenter registries of t-PA use.5,6 In addition to standard criteria, MRI-specific eligibility criteria were applied in 97 patients. MRI was not performed in 23 patients because of contraindications to MRI or late patient arrival (>2.5 hours). Outcomes were the modified Rankin Scale (mRS) obtained at 3 months.

Results—Times to treatment (median door-to-needle time 81.5 minutes; median onset-to-needle time 135 minutes) and outcomes (mRS 0 to 1, 40.8%; mRS 0 to 2, 47.5%) were not inferior to those of the typical clinical practice. Door-to-needle time was shorter in computed tomography (CT) screening (67.5±22.5 minutes; n=23) than in MRI screening (86.8±21.5 minutes; n=97, P=0.001). However, outcomes were not different between MRI screening (mRS 0 to 1, 42.9%; mRS 0 to 2, 49.5%) and CT screening (mRS 0 to 1, 34.8%; mRS 0 to 2, 59.1%). Neither times to treatment nor MRI screening was predictive of outcomes.

Conclusion—These data demonstrate that MRI screening before t-PA therapy is feasible and not associated with unacceptable times to treatment or outcomes. (Stroke. 2005;36:1930-1943.)

Key Words: magnetic resonance imaging ■ stroke ■ acute ■ thrombolysis

Kang et al. (2005) Stroke

Comparison of Perfusion Computed Tomography and Computed Tomography Angiography Source Images With Perfusion-Weighted Imaging and Diffusion-Weighted Imaging in Patients With Acute Stroke of Less Than 6 Hours’ Duration
Peter Schramm, MD; Peter D. Schellinger, MD; Ernst Klotz, PhD; Kai Kallenberg, MD; Jochen B. Fiebach, MD; Sojia Kalkman, MD; Sabine Heiland, PhD; Michael Krauth, MD; Klaus Sartor, MD

Background and Purpose—We aimed to determine the diagnostic value of perfusion-computed tomography (PCT) and CT angiography (CTA) including CTA source images (CTA-SI) in comparison with perfusion-weighted magnetic resonance imaging (PWI) and diffusion-weighted MRI (DWI) in acute stroke <6 hours.

Methods—Noncontrast-enhanced CT, PCT, CTA, stroke MRI, including PWI and DWI, and MR angiography (MRA), were performed in patients with symptoms of acute stroke lasting <6 hours. We analyzed ischemic lesion volumes on patients’ arrival as shown on NECT, PCT, CTA-SI, DWI, and PWI (Winconex, Siemens, BiAs4-A) and compared them to the infarct extent as shown on day 5 NECT.

Results—Twenty-two stroke patients underwent CT and MRI scanning within 6 hours. PCT time to peak (PCT-TTP) volumes did not differ from PWI-TTP (P=0.686) for patients who did not undergo thrombolysis (P=0.328 for patients who underwent thrombolysis, nor did PCT cerebral blood volume (PCT-CBV) differ from PWI-CBV (P=0.191). CTA-SI volumes did not differ from DWI volumes (P=0.465; P=0.056). Lesion volumes measured in PCT maps significantly correlated with lesion volumes on PWI (r=0.0047, P=0.0019, r=0.0054, r=0.0026, r=0.0071 for CBV). Also, PCT-CBV lesion volumes significantly correlated with follow-up CT lesion volumes (P=0.0017, r=0.0046, r=0.019).

Conclusions—In hyperacute stroke, the combination of PCT and CTA can render important diagnostic information regarding the infarct extent and the perfusion deficit. Lesions on PCT-TTP and PCT-CBV do not differ from lesions on PWI-TTP and PWI-CBV; lesions on CTA source images do not differ from lesions on DWI. The combination of noncontrast-enhanced CT (NECT), perfusion CT (PCT), and CT angiography (CTA) can render additional information within <15 minutes and may help in therapeutic decision-making if PWI and DWI are not available or cannot be performed on specific patients. (Stroke. 2004;35:1652-1658.)

Key Words: stroke ■ acute ■ perfusion ■ computed tomography ■ angiography ■ magnetic resonance imaging
Patient IL

- 89 yo female with h/o AF and HTN who is an in-patient treated for hemorrhoids and p/w an inability to move her left side and *unable to speak*.
- Her history indicated that she was in her usual state of health at 8pm and then symptomatic at 9pm.
- Relevant meds: ASA, HCT, ACE-i, B-blocker
- Neuro exam: Minimally reactive left pupil, left hemianopsia/neglect, left facial droop, no movement on left, upgoing left toe.
- NIH stroke score: 20/75
Immediately s/p stroke: Non-contrast CT Axial View

Dense MCA sign on the right (M1 segment), highly suspicious for acute occlusion. Confirm with CTA or MRI/MRA.

Image courtesy of Dr. Kleefield
Anatomy: Circle of Willis

Victor and Ropper (2001), p. 827
Immediately s/p stroke: CTA
Axial View

Complete occlusion of the M1 segment of the right MCA

Image courtesy of Dr. Kleefield
Immediately s/p stroke: CTA Coronal View

Image courtesy of Dr. Kleefield
Immediately s/p stroke: CTA Maximal intensity projection

Image courtesy of Dr. Kleefield
Immediately s/p stroke:
CTA Circle of Willis Volume Rendered

Volume Rendering  No cut

DFOV 18.0cm
STND/+ 

No VOI
kv 120
mA 400
Rot 0.50s/IE 39.4mm/rot
0.6mm 0.984:1/0.6sp
Tilt: 0.0
10:04:22 PM
W = 4095 L = 2048

Image courtesy of Dr. Kleefield
Patient IL: Hospital Course

- 1 hour after start of symptoms: Tissue plasminogen activator given.
- 2 hours after start of symptoms: bradycardia, hypotension, and respiratory distress.
3 hrs s/p stroke: Non-contrast CT Axial View

Focal area of hyperattenuation in the right side of the medulla consistent with hemorrhage after thrombolysis

Image courtesy of Dr. Kleefield
12 hrs s/p stroke: MRI T2 Gradient Echo Axial View

Hypointense lesion consistent with hemorrhage within the medulla

Image courtesy of Dr. Kleefield
12 hrs s/p stroke: MRI T2 Gradient Echo Axial View

Image courtesy of Dr. Kleefield

Proximal clot with blooming artifact into M1
12 hrs s/p stroke: MRI T2 DTI and ADC Axial View

Restricted diffusion involving the body of the right caudate nucleus, the right lentiform nucleus, and the right perialtrial white matter consistent with acute brain ischemia.

Image courtesy of Dr. Kleefield
12 hrs s/p stroke: MRI T2 FLAIR Axial View

Elevated FLAIR signal indicating edema and compatible with relatively acute infarct

Image courtesy of Dr. Kleefield
Immediately s/p stroke: CTA

12 hrs s/p stroke: MRA

Suggestion of propagation of clot towards the vessel’s origin

*Image courtesy of Dr. Kleefield*
Patient IL: Summary of Hospital Course

- Patient suffered an acute ischemic stroke
- TPA given within 3-hour window
- Brainstem hemorrhage 2 hours after thrombolysis
- 2 days s/p stroke, patient’s condition deteriorated
- 3 days s/p stroke, after discussions with family, patient was placed on comfort measures only
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References